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(71) Applicant *(for all designated States except US)*: GLOW DOG, INC. [US/US]; 50 Beharrel Street, Concord, MA 01742 (US).

(72) Inventors; and
(75) Inventors/Applicants *(for US only)*: MARCUS, Beth, A. [US/US]; Glow Dog, Inc., 50 Beharrel Street, Concord, MA 01742 (US). FONTANA, Richard [US/US]; Glow Dog, Inc., 50 Beharrel Street, Concord, MA 01742 (US). CORCORAN, Christopher, J. [US/US]; Glow Dog, Inc., 50 Beharrel Street, Concord, MA 01742 (US). COPE, David, B. [US/US]; Glow Dog, Inc., 50 Beharrel Street, Concord, MA 01742 (US).

(74) Agent: SOLOWAY, Norman, P.; Hayes, Soloway, Hennessey, Grossman & Hage, 175 Canal Street, Manchester, NH 03101 (US).

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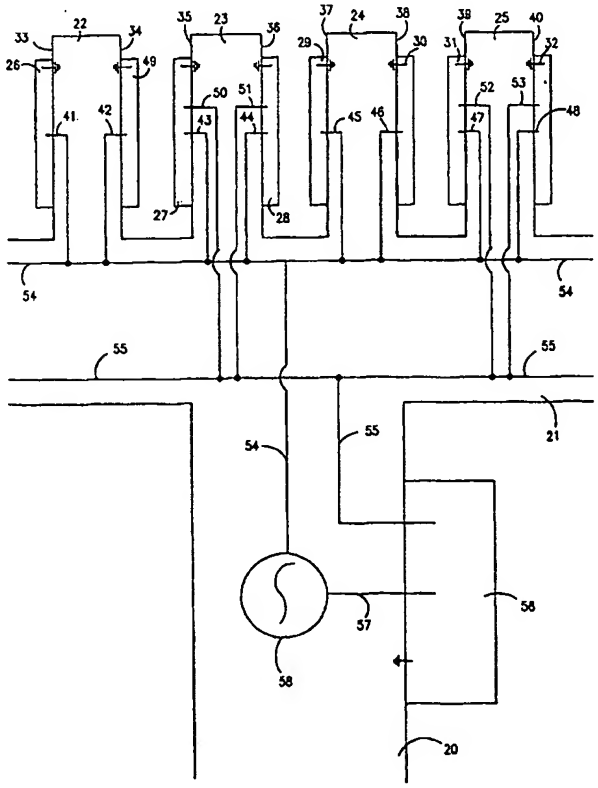
(54) Title: APPARATUS AND METHOD TO DETECT A TICK OR OTHER PEST IN FUR OR HAIR

(57) Abstract

A comb or brush (10) incorporating optical, resistive, capacitative, infrared, ultrasonic or chemical sensors (27, 28) to detect the presence of a tick or other pest in fur or hair.



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APPARATUS AND METHOD TO DETECT A TICK OR OTHER PEST IN FUR OR HAIR

The present invention relates to an improved comb or brush (hereinafter individually and collectively referred to as a "comb"), and method for using same to detect the presence of a pest in the fur or hair of an animal. The invention has particular utility for use in detecting the presence of a tick in the fur or hair of a pet, and will so be described in connection with such utility, although other utilities are contemplated such as detection of mites, leeches or the like in fur or hair or on the skin of a pet or a human.

Ticks are pests which feed off the blood of mammals. Ticks are also known to carry disease, including Lime Disease. Ticks often attach themselves to the skin or fur of pets. If the pet has a tick collar, then the tick may shed itself from the carrier pet, perhaps right into the home, or if carried long enough, lay eggs in the home. Children and adults are then subjected to the diseases and nuisance of tick bites ever without venturing out of doors. The present invention provides a device to detect the presence of ticks by their physical attributes, namely physical size, thermal characteristics, dielectric polarizability, and other phenomena discussed below.

Applicants' invention comprises a number of embodiments which detect ticks on pets. For example in a first embodiment, optical sources and associated optical sensors are placed on neighboring teeth of a pet comb. When a tick is located between two teeth of the comb, its presence can be detected because the tick will block the light emitted from one of the optical sources from illuminating one of the optical sensors.

In a second embodiment, electrical conductors carrying low voltage signals are incorporated into the teeth of the pet comb. The presence of a tick between two neighboring teeth results in a current flow which is measured by a current meter.

In a third embodiment, an electrical circuit is formed from conductors which cover at least in part the teeth of the pet comb. The presence of a tick between two neighboring teeth, or in near proximity to one of the teeth, results in an increase in the capacitance of the electrical circuit due to the presence of the tick. The exo-skeleton of the tick is conductive and has a measurable dielectric constant. In addition, a tick

comprises largely water, and that water has a measurable dielectric constant.

In a fourth embodiment, an infrared detector is placed on the pet comb. This detector can measure the temperature difference between a tick and the pet's skin, and thereby detect the presence of a tick in the pet's fur.

In a fifth embodiment, an ultrasonic sound wave emitter is placed on the pet comb along with an ultrasonic sound wave receiver. The wavelength of the ultrasonic waves emitted is chosen such that a tick will reflect those sound waves. Reception of reflected sound waves and reception of those reflected sound waves by the ultrasonic wave receiver causes a signal to be generated and a message is displayed on a display device attached to the pet comb.

In a sixth embodiment, an electronic nose or sniffer is placed on the pet comb. This detector can measure volatile chemicals or odors given off by a tick or other pest.

The invention will be better understood from a reading of the following detailed description taken in conjunction with the drawings in which like reference designators are used to designate like elements, and in which:

FIG. 1 is a top perspective view of the pet comb according to the present invention;

FIG. 2 is a partial schematic of the first embodiment of the invention;

FIG. 3 is a partial schematic of a second embodiment of the invention;

FIG. 4 is a partial schematic of a third embodiment of the invention;

FIG. 5 is a partial schematic of a fourth embodiment of the invention;

FIG. 6 is a partial schematic of a fifth embodiment of the invention; and

FIG. 7 is a partial schematic of a sixth embodiment of the invention.

With reference first to FIG. 1, there is shown a pet comb embodying the present invention. The pet comb 10 comprises handle 12 upon which is disposed a T-bar frame 14. The axis of T-bar frame 14 is essentially perpendicular to the axis of handle 12. A plurality of substantially aligned teeth 16 are attached to, and project outwardly from, T-bar frame 14. Handle 12 and T-bar frame 14 can be formed from conventional materials including wood, plastic, or metal.

Turning to FIG. 2, a first embodiment of Applicants' invention is shown which

utilizes optical methods to detect the presence of a tick in a pet's fur. FIG. 2 shows a partial schematic view of the invention including handle portion 20 and T-bar frame portion 21. Power source 58 is internally disposed within handle 20. Power source 58 includes an "on-off" switch. When the switch is placed in the "off" position, no power flows from power source 58.

In one alternative, power source 58 comprises a battery. The battery comprising power source 58 can be of a non-rechargeable or a rechargeable variety, in which latter case power source 58 may comprise such a rechargeable battery along with a means for recharging same. In the alternative, power source 58 may comprise a power cord having a standard male connector disposed on its distal end portion which can be plugged into a standard wall outlet. In this alternative, power source 58 also may include a transformer/rectifier apparatus to produce DC voltage.

The Fig. 2 embodiment includes a plurality of first teeth 22, 24, along with a plurality of second teeth 23, 25. As can be seen on FIG. 2, the first teeth 22, 24 and second teeth 23, 25 are substantially aligned, and are disposed so that every other tooth along T-bar frame 21 comprises a first tooth disposed between two second teeth..

First tooth 22 has two opposite sides 33, 34 which are opposite and preferably parallel to one another and preferably are substantially perpendicular to the axis of T-bar frame 21, and which are also substantially parallel to the axis of handle 20. Similarly, tooth 24 has two opposite sides 37, 38 which are opposite and parallel to one another.

Second tooth 23 also has two opposite sides 35, 36 are opposite and parallel to one another, and which are substantially perpendicular to the axis of T-bar frame 22 and substantially parallel to the axis of handle 20.

Optical source 26 is disposed on side 33 of tooth 22, and optical source 49 is disposed on the opposite side 34 of tooth 22. Similarly, optical source 29 is disposed on side 37 of tooth 24 and optical source 30 is disposed on the opposite side 30 of tooth 24. Alternatively, the optical source may be located elsewhere on the device, and light-guided to the comb teeth by optical fiber. Power buss 54 is connected to power source 58 and is internally disposed within handle 20 and is also internally disposed within T-bar frame 21. Power cable 41 is connected to power buss 54 and optical source 26.

Optical source 26 receives power from power source 58 via power buss 54 and power cable 41. Similarly, optical source 49 receives power from power source 58 via power buss 54 and power cable 42. Turning to tooth 24, optical sources 29 and 30 receive power from power source 58 via power buss 54 and power cables 45 and 46, respectively. Optical sensor 27 is disposed on side 35 of second tooth 23. Optical sensor 28 is disposed on the opposite side of tooth 23, namely side 36. Optical sensor 27 receives power from power source 58 via power buss 54 and power cable 43. Similarly, optical sensor 28 receives power from power source 58 via power buss 54 and power cable 44.

Optical sensor 27 has two states, namely a dark state and an illuminated state. When operative, i.e. when receiving power from power source 58, optical sensor 27 provides an output signal when that sensor is in the dark state.

Display device 56 is connected to power source 58 by conductor 57. Communication buss 55 is internally disposed within handle 20 and T-bar frame 21. Communication link 43 is connected to optical sensor 27 and communication buss 55. In the event optical sensor 27 changes from the illuminated state to the dark state, optical sensor 27 generates a signal and communicates that signal to display device 56 via communication link 43 and communication buss 55.

Tooth 22 and tooth 23 are disposed on T-bar frame 21 such that optical source 49 illuminates optical sensor 27. Similarly, tooth 23 and tooth 24 are disposed on T-bar frame 54 such that optical sensor 29 illuminates optical source 28. Power cables 41, 42, 43, 44, 45, 46, and 57 are selected to ensure sufficient current-carrying capability for the devices powered by those power cables, and can be formed using conventional materials such as copper or aluminum, which may be solid wire or multiple strands of wires.

When the pet comb of this embodiment is pulled through the fur of a pet, the individual teeth of the comb will extend through that fur to near proximity to the pet's skin. In the event an offending pest such as a tick, mite, leech, or the like, is encountered, that offending pest will partially occupy the space between adjacent teeth of the pet comb, and block the light emitted from one of the optical sources on the tooth. This light blockage will be different than the blockage due to the fur of the pet.

Therefore, one of the optical sensors disposed on a neighboring second tooth will no longer be illuminated by the "blocked" optical source. That affected optical sensor will then change from the illuminated state to the dark state, and will generate a signal which is communicated to the display device in the manner described above. In one embodiment, the display device will emit an audible sound indicating the presence of the offending pest. Alternatively, the display device may display a visual alarm regarding the presence of the offending pest.

A second embodiment uses a resistive method to detect the presence of offending pests. This second embodiment comprises the same general configuration shown in Fig. 1, and includes a handle 12, T-bar frame 14 and a plurality of teeth 16 attached to and extending outwardly from T-bar frame 14. However, as shown in FIG. 3, in this second embodiment a current/voltage meter 74 is disposed on handle 71. Power source 73 is internally disposed within handle 71. As before power source 73 includes an "on-off" switch, and includes a battery or a power cord for connecting to an AC power source.

The FIG. 3 embodiment includes a plurality of teeth disposed on T-bar frame 72 from of which teeth 75, 76, 77 and 78 are shown. Teeth 75, 76, 77 and 78 are mounted on, and extend outwardly from, T-bar frame 72. Adjacent teeth 75 and 76 are discussed in detail below in order to describe the operation of this second embodiment. It should be noted, however, that all of the plurality of teeth comprising this second embodiment are identically configured, and operate in the fashion described below for teeth 75 and 76.

Tooth 75 has two opposite sides 79 and 81 which are substantially perpendicular to the axis of T-bar frame 72, and which are also substantially parallel to the axis of handle 71. Similarly, tooth 76 includes opposite and parallel sides 83 and side 85. External conductor 80 is disposed on side 79 of tooth 75, and external conductor 82 is disposed on side 81 of tooth 75. If desired, insulators (not shown) may be placed on the distal ends of the teeth to reduce the possibility of shock.

Power source 73 is internally disposed within handle 71. Conductor 87 is internally disposed within handle 71 and T-bar frame 72, and connects power source 73

to conductor 95. Conductor 95 is internally disposed within tooth 75 within one end connecting to external conductor 80, and the other end connecting to external conductor 82. Conductor 91 connects current meter 74 to conductor 87, such that current meter 74 measures the current flowing through conductor 87. Similarly, external conductor 84 disposed on side 83 of tooth 76 is connected to power source 73 via conductors 88 and 96.

The electrical pathway defined by power source 73, conductor 87, conductor 95, and external conductor 82 comprises an open circuit as shown in FIG. 3. Similarly, the electrical pathway defined by power source 73, conductor 88, conductor 96, and external conductor 84 also comprises an open circuit.

When the pet comb of this embodiment is pulled through the fur of a pet, the individual teeth of the comb will extend through that fur to near proximity to the pet's skin. The spacing between tooth 75 and tooth 76 is fixed so that in the event a tick is encountered, that offending tick will bridge the space between teeth 75 and 76. Because the tick's exo-skeleton is electrically conductive, the presence of such a tick between teeth 75 and 76 will complete an electrical circuit and current will flow along the circuit defined by power source 73, conductor 87, conductor 95, external conductor 82, exo-skeleton of the tick, external conductor 84, conductor 96 and conductor 88. Current meter 74 attached to the above-defined circuit via conductors 91 and 92 displays the current flowing through that now closed circuit.

Since each of the plurality of teeth comprising this second embodiment have electrical configurations identical to those shown for teeth 75 and 76, in the event a tick contacts any two adjacent teeth, current meter 74 will indicate the presence of that tick by displaying current flow.

The third embodiment of Applicant's novel invention again utilizes the basic design recited in FIG. 1, including a handle, T-bar frame attached to that handle, and a plurality of teeth attached to and extending outwardly from the T-bar frame. This embodiment uses a capacitative method to detect the presence of a tick.

Referring to FIG. 4, a partial schematic of this embodiment is shown. T-bar frame 102 is attached to one end of handle 101. Teeth 103, 104, 105, and 106 are

attached to, and extend outwardly from, T-bar frame 102. Power source 107 is internally disposed in handle 107. Power source 107 comprises a battery, which battery may be a disposable battery or a rechargeable battery, in which ease power source 107 also may comprise means to recharge the battery. Alternatively, power source 107 may comprise a power cord having a standard male adapter for insertion into to a standard 115 volt AC wall outlet, a transformer, and a rectifier to produce DC current.

Power buss 109 is internally disposed in handle 101, and connects to one terminal of power source 107. Power buss 109 extends into and is internally disposed within T-bar frame 102 as shown in FIG. 5. Power buss 110 is also internally disposed in handle 101, and connects to the second terminal of power source 107. Power buss 110 extends into and is internally disposed within T-bar frame 102.

External conductor 111 covers tooth 103. External conductor can be formed from conventional materials such as copper , aluminum, or an electrically conductive polymeric material. Conductor 112 is internally disposed within tooth 103 and connects external conductor 111 to power buss 109. Conductor 113 is also internally disposed within tooth 103 and connects external conductor 103 to power buss 110. Conductors 112 and 113 can be formed from conventional materials such as copper or aluminum, and can comprise either a single wire or an assemblage of smaller wires.

Tooth 104 is configured similarly to tooth 103. A shown in FIG. 4, external conductor 116 covers tooth 104, and is connected to power source 107 via power busses 109 and 110 and conductors 117 and 118.

The remaining plurality of teeth attached to T-bar frame 102 that are not shown in FIG. 4 are each similarly covered by an external conductor which receives power from power source 107 via power busses 109 and 110. Thus, the assembly utilizes a single electrical circuit comprising power source 107, power busses 109 and 110, and a plurality of external conductors each individually connected to power busses 109 and 110 by two discrete conductors.

Capacitance meter 108 is connected to power buss 109 via conductor 115, and is also connected to power buss 110 by conductor 114. Capacitance meter 108 measures the capacitance of the single circuit described above.

When the pet comb of this embodiment is pulled through the fur of a pet, the individual teeth of the comb will extend through that fur in near proximity to the pet's skin. The spacing between teeth is fixed so that in the event a tick is encountered, that offending tick bridges the space between two adjacent teeth. The tick's exo-skeleton is electrically conductive, and has a certain dielectric constant. In addition, a tick comprises largely water which also has a dielectric constant.

The presence of a tick between two adjacent teeth changes the capacitance of the electrical circuit in the pet comb. Moreover, the presence of a tick in near vicinity to any one tooth of this embodiment will also alter the capacitance of the pet comb circuit.

Therefore, the presence of a tick can be determined by monitoring the capacitance displayed on capacitance meter 108. Capacitance meter 108 can be configured to display the capacitance of the internal circuit described above. Or in the alternative, capacitance meter 108 can be configured to emit an audible signal, or to display a visual signal, when the capacitance of the pet comb circuit changes. The capacitance meter/tooth wiring may be further subdivided or multiplexed to measure capacitance between any number of teeth for increased precision.

The fourth embodiment of Applicant's novel invention again utilizes the basic design recited in FIG. 1, including a handle, T-bar frame attached to that handle, and a plurality of teeth attached to and extending outwardly from the T-bar frame.

Referring to FIG. 5, T-bar frame 122 is attached to one end of handle 121. T-bar frame 122 has a left distal end portion 123, a right distal end portion 124, and a middle portion 125. A plurality of teeth 126 are attached to both left distal end portion 123 and right distal end portion 124. No teeth, however, are attached to middle portion 125 of T-bar frame 122.

This embodiment uses an infrared detector to detect the presence of a tick. Infrared detector 133 is disposed on the middle portion 125 of T-bar frame 122 opposite from the attachment of handle 121 to T-bar frame 122. Infrared detectors are described in the literature. See, for example U.S. Pat. No. 5,742,052.

Power source 132 is internally disposed in handle 122. Power source 132 comprises a battery, which battery may be a disposable battery or a rechargeable battery,

in which case power source 132 also comprises a means to recharge that battery. In the alternative, power source 132 may comprise a power cord having a standard male adapter for insertion into a standard wall outlet, a transformer, and a rectifier to produce DC current.

Conductor 128 is connected to a first pole of power source 132 and to infrared radiation detector 133. Conductor 129 is connected to the second pole of power source 132 and to infrared radiation detector 133. Based upon the infrared radiation detected, infrared detector 133 generates an electrical signal and communicates that signal to display device 131 via communication link 130. Display device 131 generates and displays a thermal image based upon the signal received from infrared detector 133.

When the pet comb of this embodiment is pulled through the fur of a pet, infrared radiation detector 133 is positioned just above the surface of that fur so as to detect infrared radiation emanating from any ticks hiding within that fur. In the event a tick is located in the pet's fur, the heat radiating from that tick, i.e. the infrared radiation emanated, will be detected by infrared detector 133 as it passes in near proximity to the tick. The presence of the tick can be determined by the thermal image of same displayed on display device 131.

The fifth embodiment of the invention uses reflected ultrasonic sound waves to detect the presence of a tick. This embodiment again utilizes the basic design recited in FIG. 1, including a handle, T-bar frame attached to that handle, and a plurality of teeth attached to and extending outwardly from the T-bar frame.

Referring to FIG. 6, T-bar frame 142 is attached to one end of handle 141. T-bar frame 142 has a left distal end portion 155, a right distal end portion 156, and a middle portion 157. A plurality of teeth 153 are attached to both left distal end portion 155 and right distal end portion 156. No teeth, however, are attached to middle portion 157 of T-bar frame 142.

Ultrasonic-wave emitter 148 is disposed on middle portion 157 of T-bar frame 142. Ultrasonic-wave emitter 148 transmits ultrasonic waves frontwardly in a predetermined distance from T-bar frame 142. Ultrasonic-wave generating circuit 145 is internally disposed within T-bar frame 142, and coupled to ultrasonic-wave emitter

148 by link 147. Ultrasonic - wave generating circuits are described in the literature-see, for example U.S. Pat. No. 5,170,858.

The wavelength of the ultrasonic waves generated by emitter 148 is chosen to maximize the reflection of those waves by an object having a physical size or ultrasonic impedance of a tick, i.e. having a length between about 1 mm and about 10 mm. Emitter 148 transmits those ultrasonic waves in such a pattern such that an object the size of a tick in near proximity to the emitter will reflect those ultrasonic waves.

Ultrasonic-wave receiver 149 is disposed on middle portion 157 of T-bar frame 142. Ultrasonic-wave receiver 149 receives a ultrasonic-wave signal emitted by ultrasonic-wave emitter 148 and reflected from the body of a tick. Upon receiving such a reflected signal, ultrasonic-wave receiver 149 communicates a signal to ultrasonic-wave receiving circuit 146 via link 150.

Ultrasonic-wave receiving circuit 146 is internally disposed within T-bar frame 142. Ultrasonic-wave receiving circuits are described in the literature. See, for example U.S. Pat. No. 5,170,858. Ultrasonic-wave receiving circuit 146 receives signals from ultrasonic-wave receiver 149 and amplifies those signals and communicates that amplified signal to display device 152 via link 151. Display device 152 is disposed on handle 141, and displays a visual message upon receipt of a signal. In the alternative, display device 152 emits an audible tone upon receipt of a signal from ultrasonic-wave receiving circuit 146 via link 151.

Power source 143 is internally disposed in handle 141. Power source 143 comprises a battery, which battery maybe a disposable battery or a rechargeable battery, in which case power source 143 also comprises a means to recharge that battery. In the alternative, power source 143 may comprise a power cord having a standard male adapter for insertion into to a standard wall outlet, a transformer, and a rectifier to produce DC current.

Power source 143 is connected to power buss 144. Power buss 144 connects to ultrasonic-wave generating circuit 154, ultrasonic-wave emitter 148, ultrasonic-wave receiver 149, ultrasonic-wave receiving circuit 146, and display device 152, and provides power to those devices.

When the pet comb of this embodiment is pulled through the fur of a pet, ultrasonic-wave emitter 148 is positioned just above the surface of that fur, and emits ultrasonic-waves into that fur. Ultrasonic-wave receiver 149 is also positioned just above the surface of the pet's fur such it will receive any reflected ultrasonic-waves. In the event a tick is present in the pet's fur or on the pet's skin, the body of that tick will reflect the waves emitted by ultrasonic-wave emitter 148. Upon receiving those reflected ultrasonic-waves by receiver 149, ultrasonic-wave receiving circuit 146 will send a signal to display device 152. Display device 152 will display a visual message or emit an audible tone alerting the user to the presence of the tick.

Referring to FIG. 7, yet another embodiment of our invention employs an olfactory sensor identification system and including one or a plurality of gas sensors 200 mounted on the teeth or frame, together with an associated detector circuit 202 such as taught in U.S. Patent 5,675,070. Combing or brushing the fur or hair creates sufficient relative air movement past the sensors 200, so that the distinctive area of the pest becomes mixed with the air and carried into contact with the sensors 200.

Thus, the present connection provides a pet comb or brush which serves the dual purpose of grooming and aiding in the detection of ticks or other pests in a pet's fur or hair. The comb or brush of the present invention also advantageously may be used for detecting ticks or other pests in a person's hair.

Yet other changes may be made without departing from the spirit and scope of the invention.

We claim:

1. A comb or brush comprising, in combination;

a handle 12;

a plurality of elongated teeth 16; and

an electrically operated sensor operatively disposed on said comb or brush for detecting the presence of a pest present in the fur or hair or on the skin.

2. The comb or brush of claim 1, and including a power source 58 disposed in said handle.

3. The comb or brush of claim 2, wherein said power source 58 comprises a battery.

4. The comb or brush of claim 3, wherein said battery comprises a disposable battery.

5. The comb or brush of claim 3, wherein said battery comprises a rechargeable battery, said comb or brush further including a battery recharging circuit.

6. The comb or brush of claim 1, wherein said power source 58 comprises an external power source, said comb or brush further including a cord for connection to said external power source.

7. The comb or brush of claim 1, wherein said sensor comprises an optical sensor.

8. The comb or brush of claim 7, and including a plurality of elongated substantially aligned first and second teeth 22,23, extending from said handle;

a plurality of optical sources 26, 29, 49 and a plurality of optical sensors 27, 28, operatively disposed facing one another on adjacent teeth, each of said plurality of said optical sensors having an illuminated state and a dark state;

a display 56 disposed on said comb or brush, and connected to said optical sensors and said power source via a plurality of communication links 41, 42, 43, 44, 45, 46, 57.

9. The comb or brush of claim 8, wherein said display 56 comprises a visual display.

10. The comb or brush of claim 8, wherein said display 56 comprises a sound generator.

11. A comb or brush of claim 1, and further including a current meter 74 for signaling the presence of a pest.

12. The comb or brush of claim 11, and including a plurality of elongated teeth 75, 76, 77, 78 extending from said handle;

a plurality of electrical conductors 80, 82, respectively disposed on said plurality of teeth; and

a current meter 56 disposed on said comb between said electrical conductors and said power source for signaling the presence of a pest.

13. The comb or brush of claim 12, wherein each of said plurality of teeth 75, 76, 77, 78 is formed at least in part of an electrically conductive material.

14. The comb or brush of claim 11, wherein said current meter 56 displays a signal representative of transmission.

15. The comb or brush of claim 11, wherein said current meter 56 displays a signal representative of capacitance.

16. The comb or brush of claim 16, and including an infrared detector 133, operatively disposed on said comb or brush and electrically coupled to said display.

17. The comb or brush of claim 1, and including

an ultrasonic-wave generator 148 operatively disposed on said comb or brush; and,

an ultrasonic-wave receiver 149 operatively disposed on said comb or brush, and electrically coupled to said display.

18. The comb or brush of claim 1, and further including an olfactory sensor for signaling the presence of a pest.

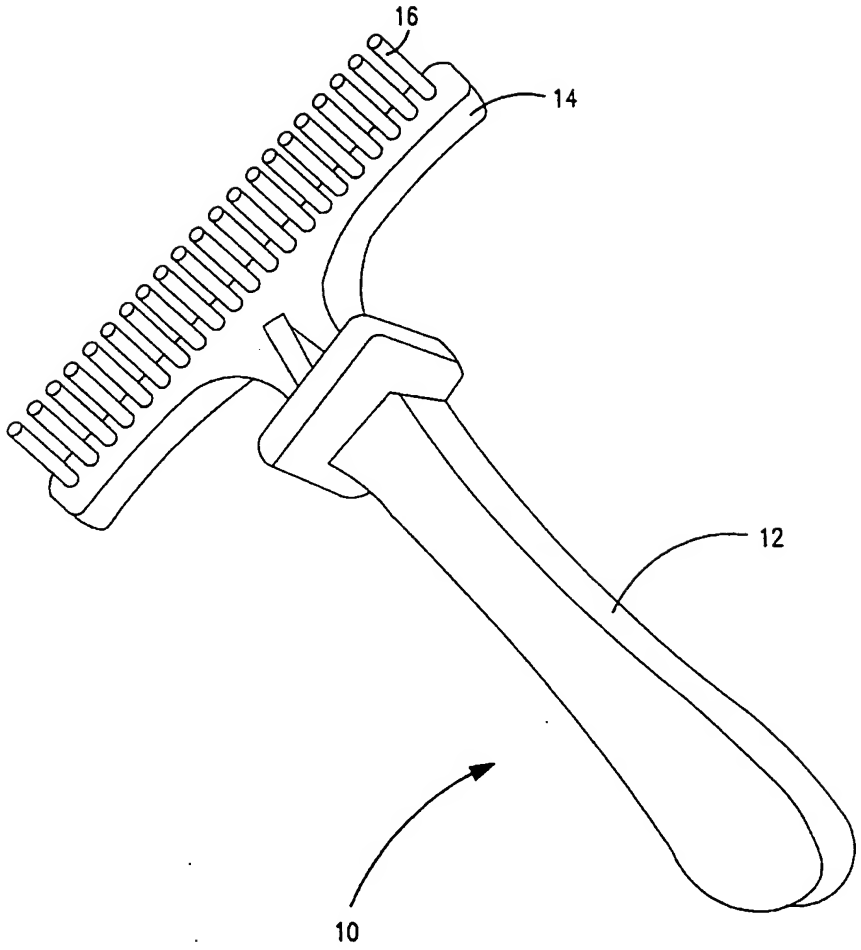

FIG. 1

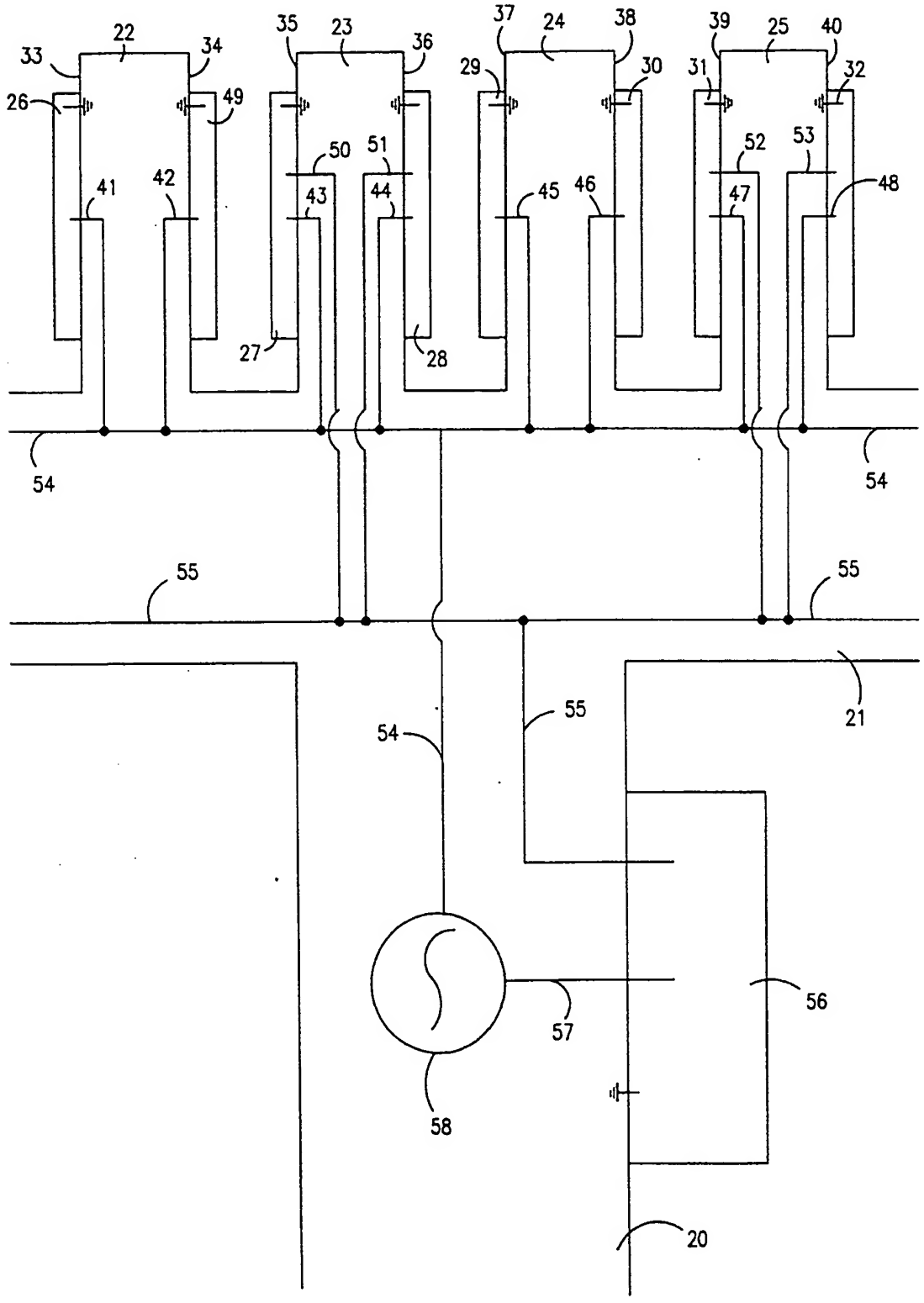
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FIG. 2

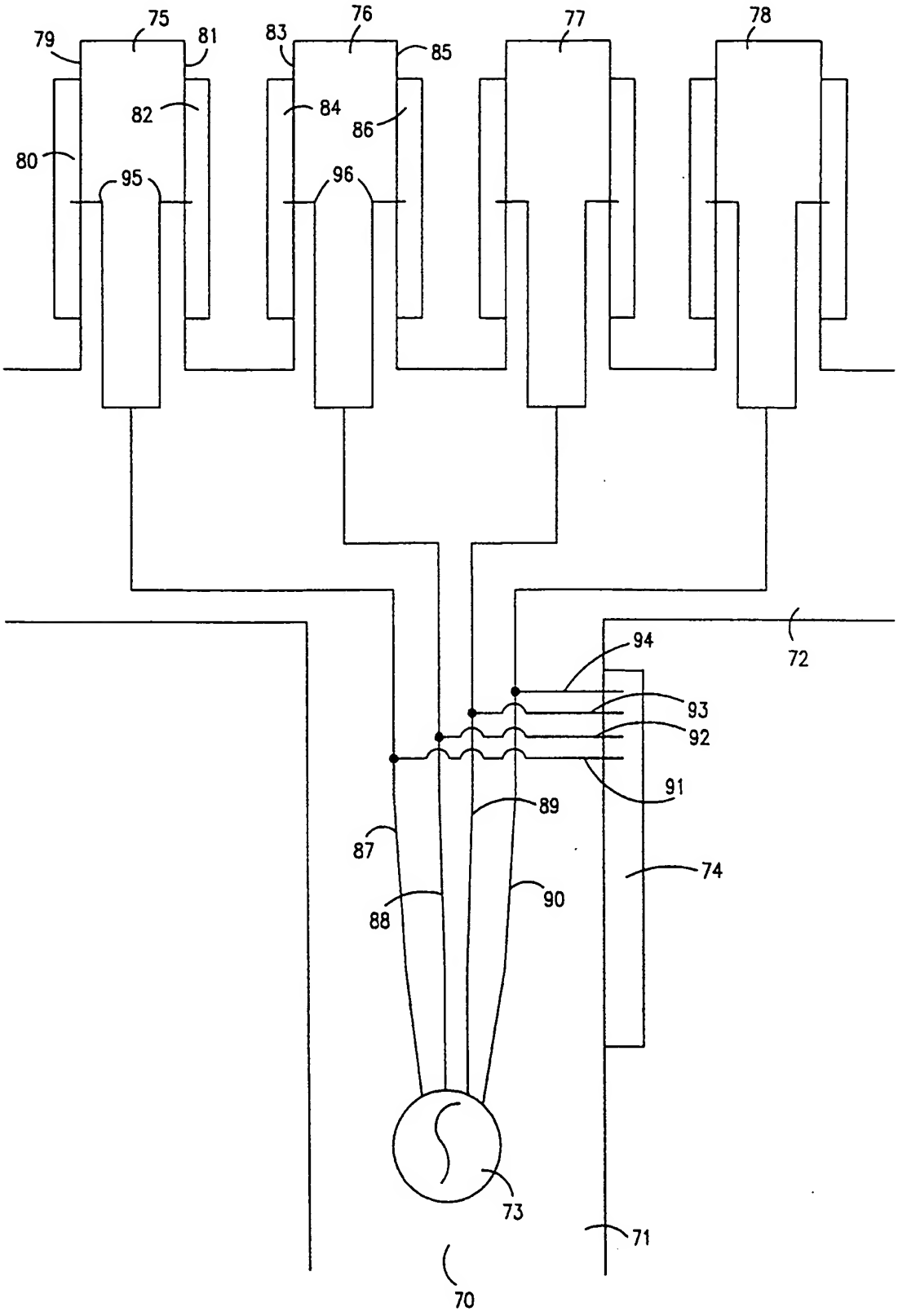
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FIG. 3

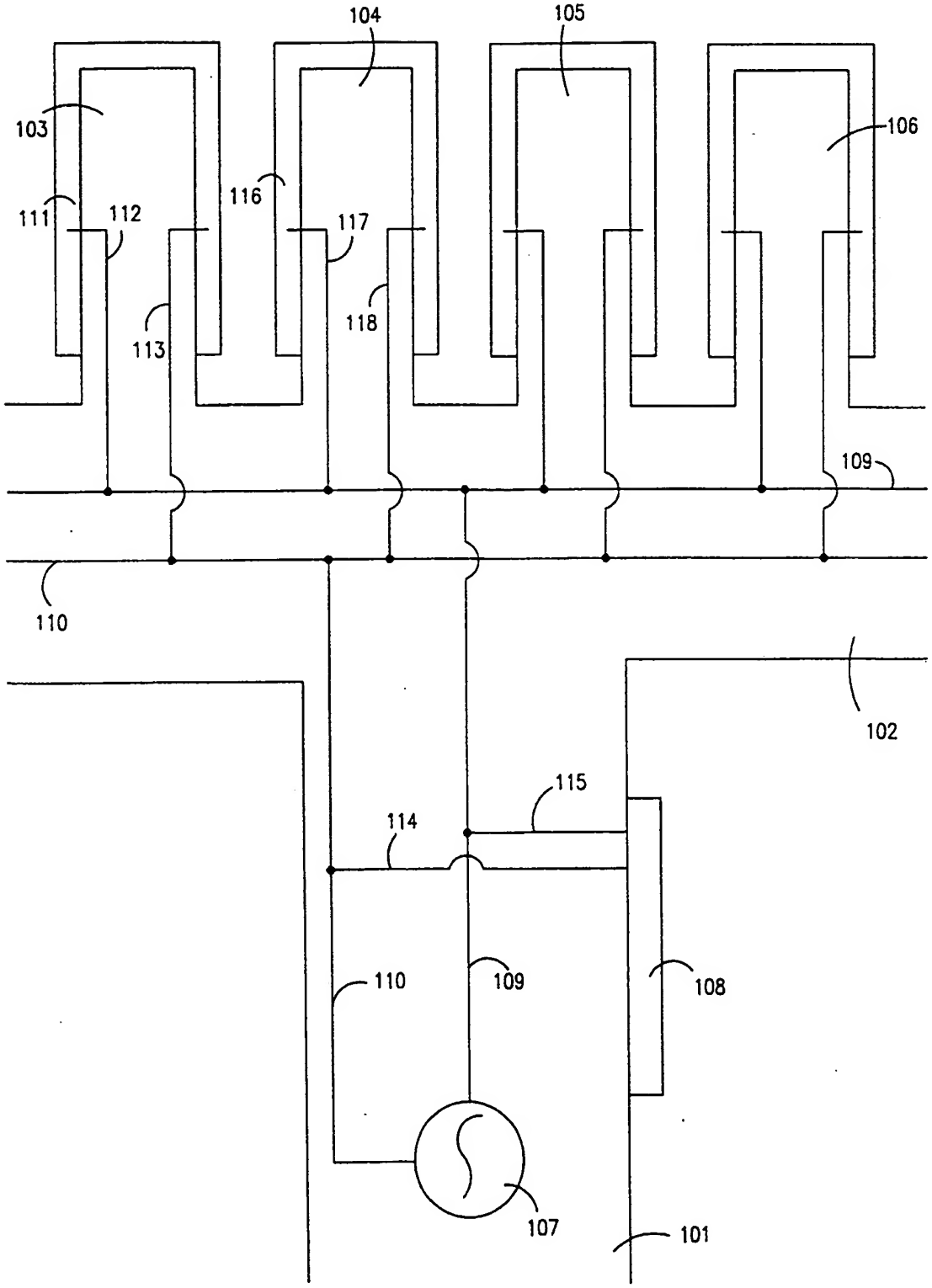
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FIG. 4

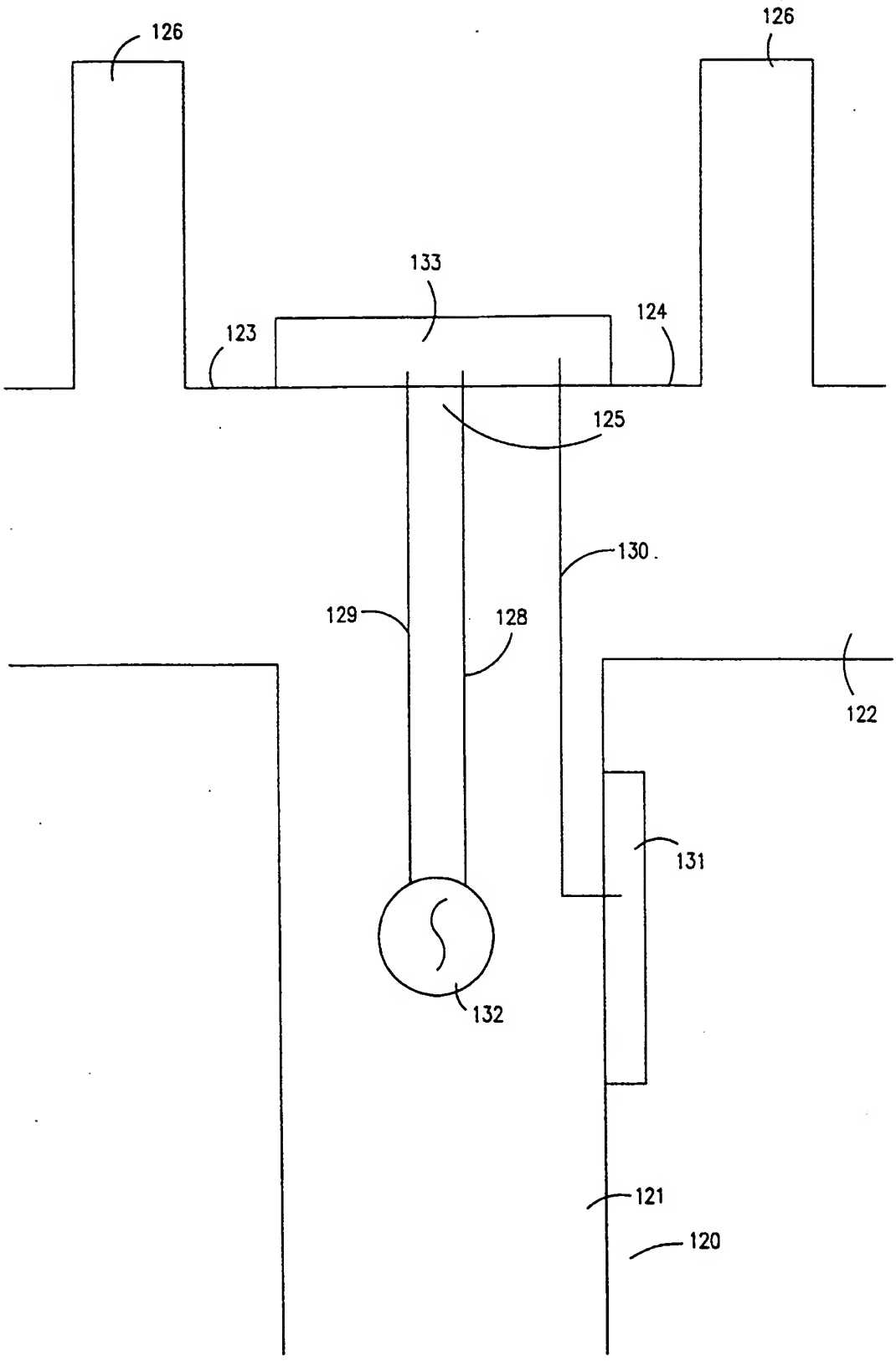

FIG. 5

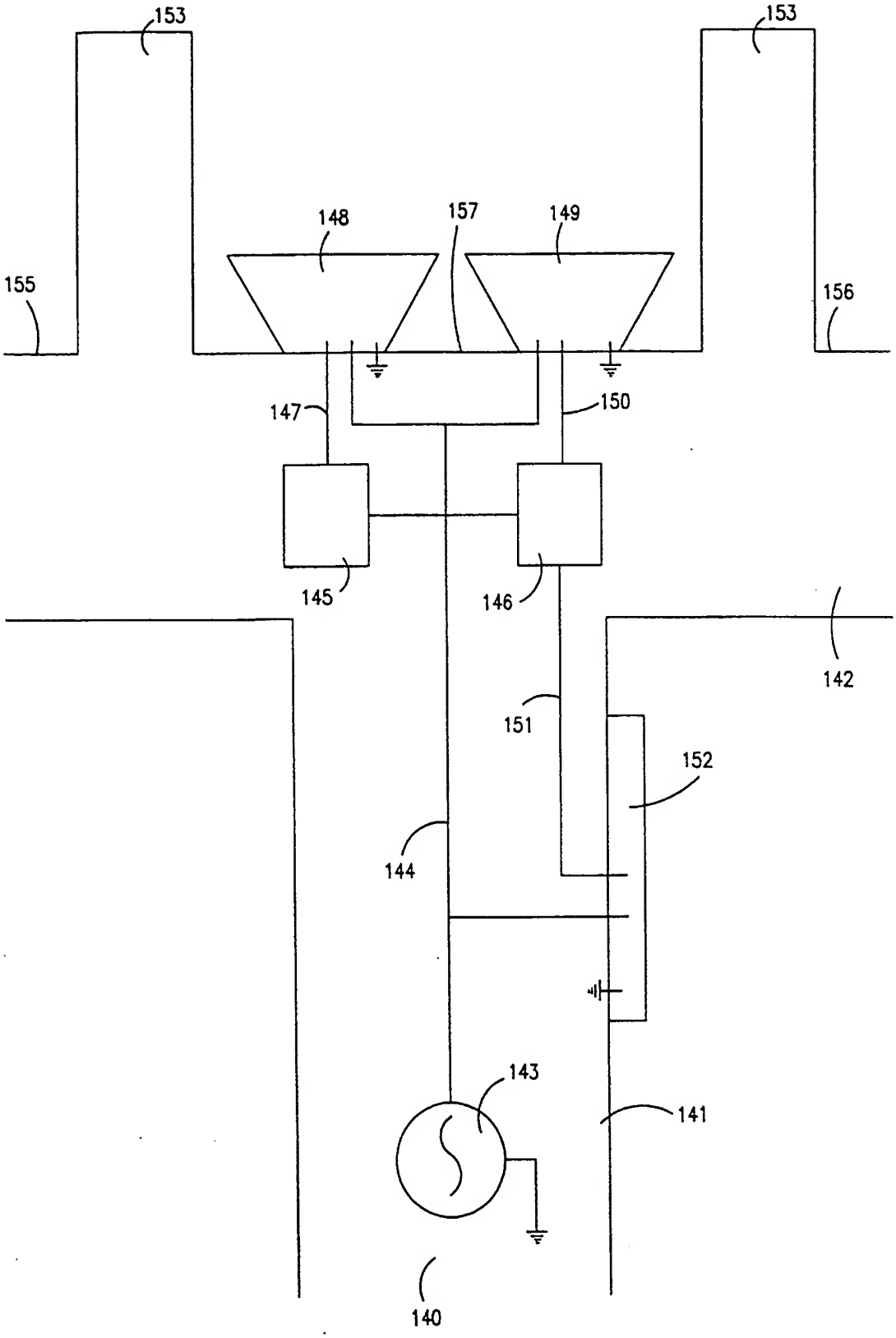
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FIG. 6

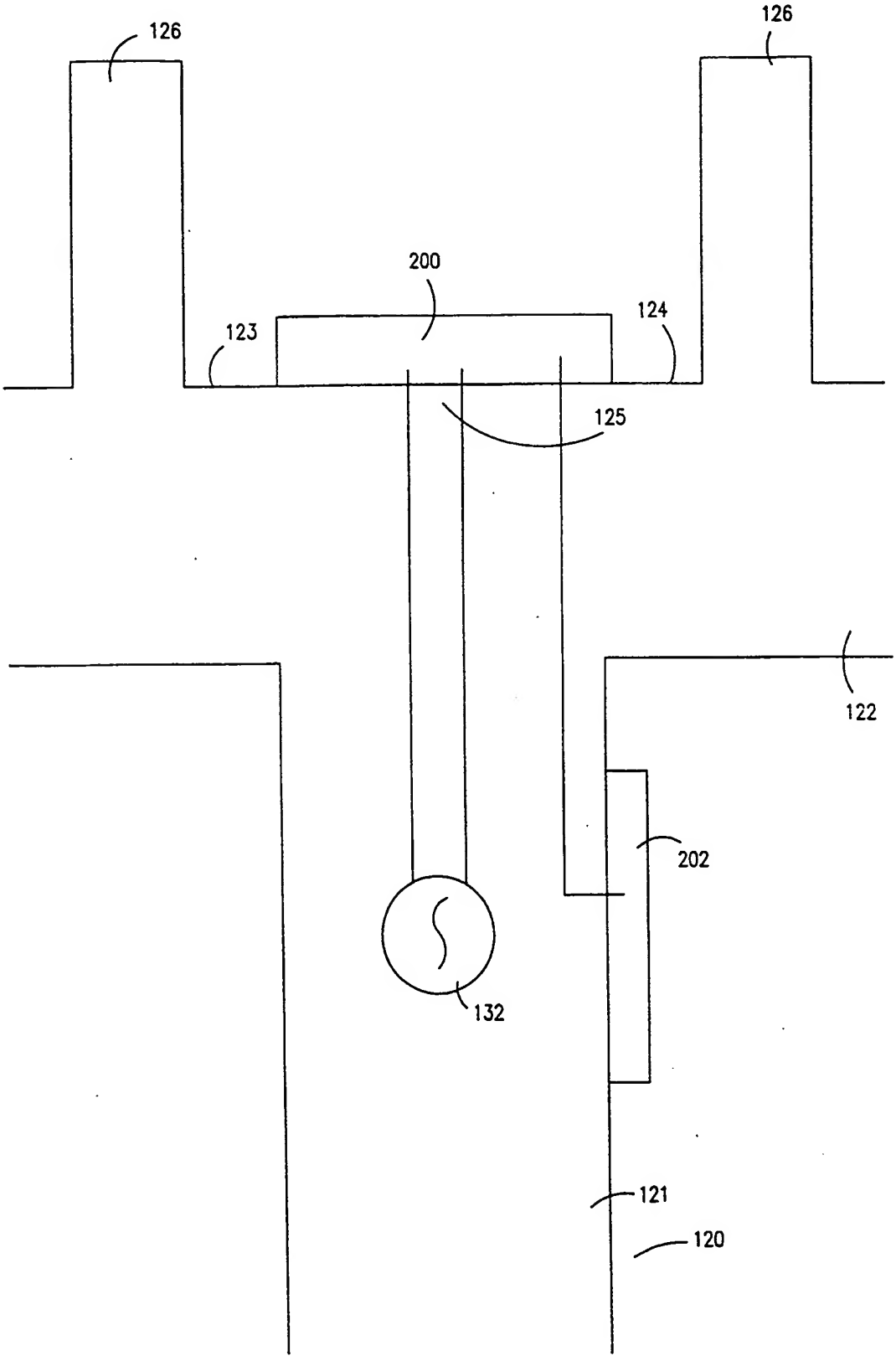

FIG. 7

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US99/14178

A. CLASSIFICATION OF SUBJECT MATTER

IPC(6) :A01K 13/00
US CL :119/601

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

U.S. : 119/601, 600, 611, 625, 626; 132/148; 15/106

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 5,353,817 A (KANTOR et al.) 11 October 1994 (11.10.94), column 4, lines 36-46.	1-18
A	US 5,626,099 A (STALLER et al.) 06 May 1997 (06.05.97), see the entire document.	1-18
A, P	US 5,870,851 A (SHOEMAKER) 16 February 1999 (16.02.99), see the entire document.	1-18

☐ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

*	Special categories of cited documents:	"T"	later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"A"	document defining the general state of the art which is not considered to be of particular relevance	"X"	document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"E"	earlier document published on or after the international filing date	"Y"	document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"L"	document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)	"&"	document member of the same patent family
"O"	document referring to an oral disclosure, use, exhibition or other means		
"P"	document published prior to the international filing date but later than the priority date claimed		

Date of the actual completion of the international search 30 JULY 1999	Date of mailing of the international search report 17 AUG 1999
Name and mailing address of the ISA/US Commissioner of Patents and Trademarks Box PCT Washington, D.C. 20231 Facsimile No. (703) 305-3230	Authorized officer ROBERT P. SWIATEK Telephone No. 703/308-2700

Form PCT/ISA/210 (second sheet)(July 1992)*